MODEL 201

VOLTOHMETER

DESCRIPTION

OPERATION

MAINTENANCE

PARTS LIST

Shasta division
BECKMAN INSTRUMENTS INC.
P.O. BOX 296, STA. A, RICHMOND, CALIF.

WARNING

Voltages dangerous to human life may be encountered in the use of this instrument. The following list of precautions should always be observed:

1. Don't work with high voltages when you are tired or when others are apt to interrupt you.

2. Don't measure any voltage without knowing its probable magnitude. Never assume that an unknown voltage is low. Always double-check your setup before measuring high voltages. Don't operate the instrument in such a way that a significant potential exists between the common connection (metal case) and ground or power. Don't ground yourself to a waterpipe. Stand on an insulated pad if possible.

3. Don't work alone; help should always be available in case of injury. The Red Cross treatment for electrical shock should be posted in the working area.

4. The cautious and experienced worker will attempt to keep one hand in his pocket when he is holding a high voltage probe in the other; he will observe the safety precautions recommended by the manufacturer of the equipment under test.

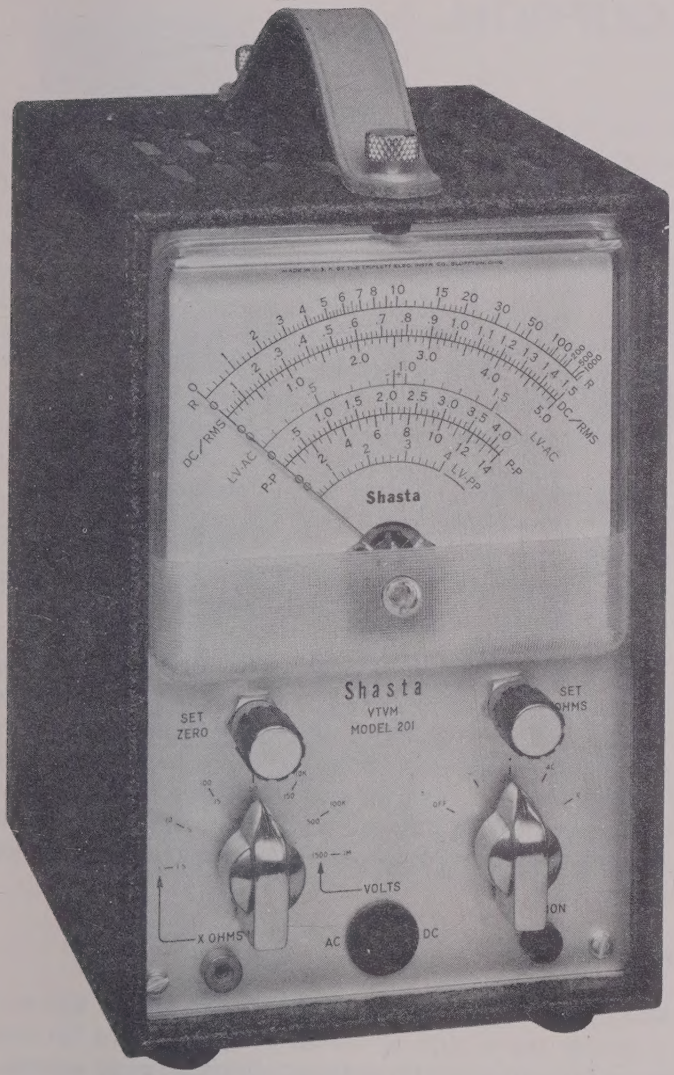


FIGURE 1 MODEL 201 VOLTOHMETER

DESCRIPTION

The Model 201 Voltohmeter is a general purpose test instrument which combines in one unit a d-c vacuum tube voltmeter, an a-c vacuum tube voltmeter and a vacuum tube ohmmeter. A versatile measuring tool, this instrument utilizes dependable circuitry combined with advanced packaging techniques. As a d-c voltmeter the Model 201 is well suited to measuring high source impedance voltages in all types of electronic circuitry, as an ohmmeter it has a readable range from .2 ohms to 1000 megohms and as an a-c voltmeter it can measure voltages up to 4000 volts peak-to-peak over a wide frequency range.

For maximum convenience a single probe is used for both a-c and d-c measurements and for easy readability the scales are lettered in contrasting colors. The meter face has a long, accurate resistance scale at the top and both rms and peak-to-peak a-c voltage scales below.

Extreme care has been used in packaging this instrument. Lightweight and small in size, the unit is designed around a vertical plane to minimize the use of valuable bench space. Tubes, transformers and major circuit elements face inward while tube sockets, resistors, capacitors and most of the wiring face outward. Excellent cooling, easy accessability, good shielding and extreme sturdiness characterize this type of construction.

ACCESSORIES

The Model 201 is supplied with the Shasta Model 953 a-c/d-c switch probe and a pair of Model 954 test leads for common and ohms connections. In addition the following accessories may be ordered from the factory.

1. Model 950 Crystal Probe - extends the frequency coverage to 250 mcs.
2. Model 951 High Voltage Probe - extends the voltage scale by a factor of 100 to a maximum safe measurable voltage of 50,000 volts.

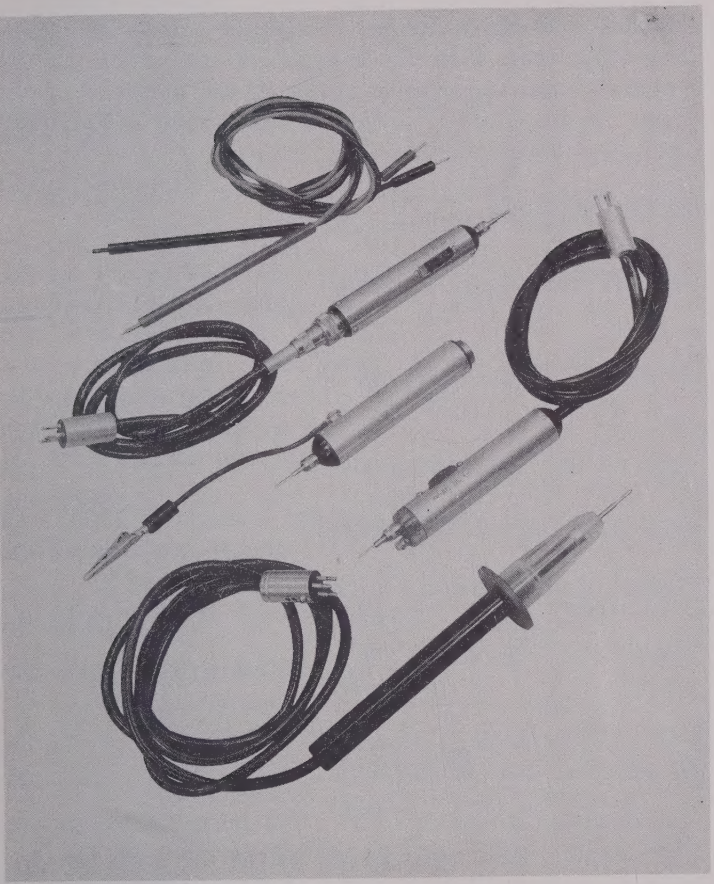


FIGURE 2 STANDARD AND ACCESSORY PROBES

Model 954 Test Leads
Model 953 AC-DC Probe
Model 950 Crystal Probe
Model 952 Illuminating Probe
Model 951 High Voltage Probe

3. Model 952 Illuma-Probe - contains a lamp which illuminates the area directly in front of the probe tip for convenient measurements in the dark corners of chassis, etc. In all other respects this probe is similar to the a-c/d-c switch probe.

SPECIFICATIONS

Ranges	d-c	0 to 1500 volts on two separate scales in seven steps
	a-c	0 to 1500 volts rms 0 to 4200 volts peak-to-peak on three separate scales in seven steps
	Resistance	.1 ohms to 1000 megohms on one scale in seven steps
Accuracy	d-c	± 3% of full scale
	a-c	± 5% of full scale within frequency limits
	Resistance	± 3%
Frequency Range		35 cps to 400 kcps. Accurate within ± 5% for a 1000Ω source impedance. Higher source impedances lower the high frequency limit The upper frequency limit for 900Ω source impedance is 500 kcps; for 10,000Ω source impedance, 50 kcps
Maximum Input Voltages	d-c	1500 volts
	a-c	1500 volts rms 4000 volts peak-to-peak

	Complex Wave	2000 volts peak-to-peak
Input Impedance (with probe)	d-c	11 megohms
	a-c	1.5 to 150 volt range 800K shunted by 100 $\mu\mu f$
		500 volt range 1.3M shunted by 80 $\mu\mu f$
		1500 volt range 1.5M shunted by 80 $\mu\mu f$
Power Requirements		105-130 volts, 50-60 cps, 6 watts. Standard D size dry cell
Tube Complement		One selected and aged 12AU7 Two selected and aged 6AL5's
Outside Dimensions		Standard Shasta SA1 size cabinet 5-1/4" wide by 8" high by 6-11/16" deep
Weight		5 pounds

OPERATION

PRELIMINARY

Connect the power cord to a 117 volt, 50-60 cps source and turn the function switch to "+". Allow the instrument to warm up for a few minutes; then adjust the SET ZERO control to zero the meter pointer. Switch to "-" and make sure that the pointer does not move. If it does, turn the instrument off and adjust the pointer by turning the plastic screw in the meter face. Repeat until the meter can be zeroed at both "+" and "-" positions of the function switch.

DC VOLTAGE MEASUREMENT

Use the Model 953 a-c/d-c probe for d-c voltage measurements up to 1500 volts. Plug the probe and the black common test lead into the appropriate sockets and turn the switch on the probe to the DC position. Turn the function switch to "+" or "-" and the range switch to a range higher than the anticipated voltage. Connect the common lead to the low or chassis side of the voltage to be measured and the probe to the high side. Read d-c voltage on the DC/RMS scale. The range switch indicates full scale value of the range being used.

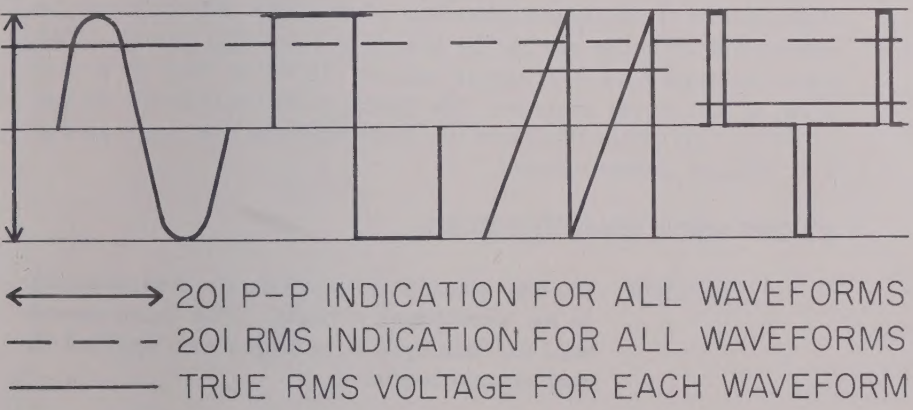
HIGH VOLTAGE MEASUREMENT - THE MODEL 951 PROBE

Measure d-c voltages above 1500 volts with the Model 951 high voltage probe. This probe attenuates the input voltage by a factor of 100, so that the actual voltage being measured is 100 times the indicated voltage. The input resistance of the instrument is increased to approximately 1, 000 megohms when used with this probe. The maximum safe input voltage is 50, 000 volts. Voltages of this magnitude are extremely dangerous and the safety precautions printed on the inside cover of this manual should be carefully followed. The Model 951 is used in the same manner as the Model 953 a-c/d-c probe.

AC VOLTAGE MEASUREMENT

Measure a-c and d-c voltage with the same probe, the Model 953. Turn both the probe switch and the function switch to the AC position and measure a-c voltages in the same manner as described for d-c voltages above. The peak-to-peak value of the input voltage is indicated on the P-P scale; rms values of sine waves are indicated on the DC/RMS scale. Separate low voltage scales marked LV P-P and LV AC in red are used when reading a-c voltages less than 1.5 volts.

Measurements of a-c voltages other than sine waves must be interpreted with care. Since the Model 201 uses a peak reading a-c circuit P-P indications will be correct for all values within the frequency range of the instrument. The rms value indicated is correct only for sine waves. The true rms value of complex waveform voltages may differ considerably from that of sine waves. In this case the indicated rms value will be incorrect. Examples are shown below.



When narrow pulses of low repetition rates are being measured the accuracy of measurement may be affected since the rectifier capacitor cannot fully charge during the short pulse nor remain charged during the long period between

pulses. The following chart shows the performance of the Model 201 in this respect for rectangular pulses at 50Ω or less source impedance.

Repetition Rate	Minimum Pulse Width for 8% Accuracy or Better
5 cps	100 μseconds
10 cps	50 μseconds
100 cps	15 μseconds
1000 cps	3 μseconds
10000 cps	2 μseconds

For symmetrical rectangular pulses having repetition rates above 35 pulses per second, the scale accuracy is always at least 8% at 50Ω or less source impedance.

HIGH FREQUENCY VOLTAGE MEASUREMENT

THE MODEL 950 PROBE

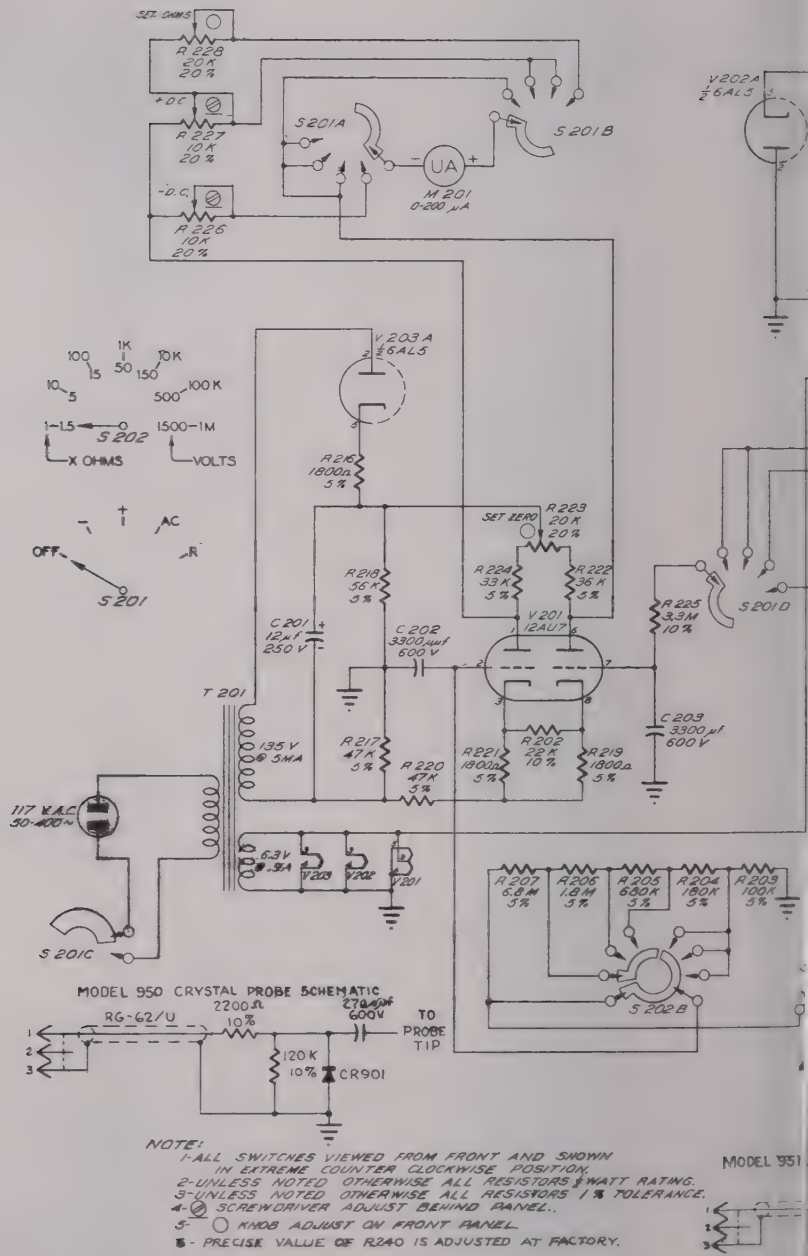
Voltages at frequencies between 50 kcs and 250 mcs can be measured with the aid of the Model 950 Crystal Probe. The function switch should be set to "+". The d-c meter scales will indicate the magnitude of the positive peak a-c voltage. The input voltage should never exceed 20 rms volts on a d-c level of 400 volts or less.

RESISTANCE MEASUREMENT

CAUTION: Do not attempt to measure resistances in an energized circuit. The instrument will be damaged if voltages are applied to resistance leads.

Resistances are measured with the Model 954 red and black test leads. Connect these leads to their appropriate sockets, set the function switch to R and the range switch to an appropriate range. Short the test leads together and adjust the SET ZERO control for a meter zero. Then separate the leads and adjust the SET OHMS control so that the meter pointer is exactly at full scale. Connect the leads to the resistance to be measured. The unknown resistance is equal to the meter reading times the range switch setting.

Low resistance, low current devices may be damaged if subjected to the full battery voltage of 1.5 volts. When measuring these units always set the range switch to R x 100 or greater.



NOTE:

1- ALL SWITCHES VIEWED FROM FRONT AND SHOWN IN EXTREME COUNTER CLOCKWISE POSITION.
2- UNLESS NOTED OTHERWISE ALL RESISTORS ½ WATT RATING.
3- UNLESS NOTED OTHERWISE ALL RESISTORS 1% TOLERANCE.
4- ⊘ SCREWDRIVER ADJUST BEHIND PANEL.
5- ○ KNOB ADJUST ON FRONT PANEL.
6- PRECISE VALUE OF R240 IS ADJUSTED AT FACTORY.

MODEL 951

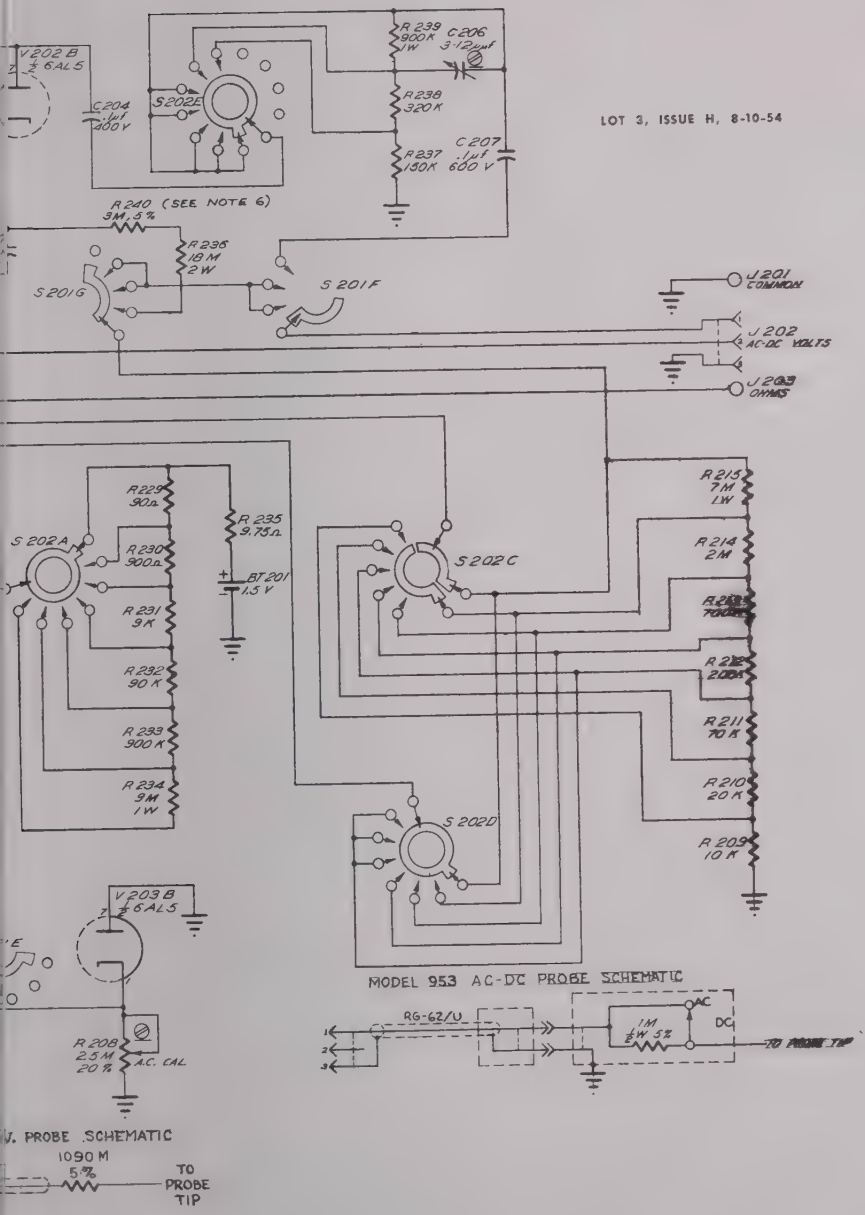


FIGURE 3 SCHEMATIC DIAGRAM, MODEL 201

MAINTENANCE

CIRCUIT DESCRIPTION

The basic voltmeter circuit of the Model 201 is a cathode coupled differential d-c amplifier (V201). With no input there is zero potential between the plates of this tube, a 12AU7 twin triode. A d-c voltage impressed on the input grid (pin 7) of V201 causes a voltage increment at the corresponding plate. In addition, since the cathodes of the two triodes are coupled together, the grid voltage change is reflected in a voltage change of the same polarity on the cathode of the other triode unit. The voltage on the plate of the second triode is, therefore, changed by an equal magnitude but opposite in polarity to that of the first plate. This difference in potential causes a current proportional to the input voltage to flow through the meter connected between the two plates. In operation, a d-c input is first attenuated by a resistor divider (R209 to R215) which establishes the scale ratios, then applied to the input grid.

Alternating voltages are rectified by a full wave voltage doubling rectifier composed of both halves of a 6AL5 twin diode (V202). The resulting d-c voltage is applied to the voltmeter circuit. To maintain a flat frequency response over all ranges an auxiliary frequency compensated voltage divider (R237 to R239, C206 & C207) is used on the higher a-c ranges. Due to the sensitivity of circuit, the cathode emission characteristics of the a-c rectifier diodes could cause a false voltage at the input grid of V201 leading to inaccuracies on the lower ranges. A similar diode and associated resistor divider (V203B & R203 to R207) is placed in the other grid circuit of V201 to balance out this effect whenever a-c is being measured. The AC ADJ control (R208) has been added to compensate for differences in cathode emission of the replacement diodes.

For resistance measurements the circuit is energized by a standard 1.5 volt dry cell. The unknown resistance then becomes part of a resistor divider (R229 to R234), the voltage output of which is measured by the voltmeter circuit.

The power supply is of conventional design. V203A, one half of a 6AL5, is the power rectifier.

GENERAL

The Model 201 should require little maintenance aside from occasional battery or tube replacement. To gain access to the instrument remove the two knurled thumb screws which hold the leather handle in place and push the chassis out of the cabinet to the rear.

Battery - The battery should be tested periodically to insure accuracy of resistance measurements. To test the battery set the function switch to R x 1 and adjust the SET OHMS control so that the pointer reads full scale. Short the resistance and common probes together for about ten seconds; then open the short circuit. If the meter pointer does not return to full scale immediately the cell is weak and should be replaced. To remove the battery, unscrew the battery bracket screws on the rear chassis. When replacing the battery, be sure that the positive end of the new battery connects with the red battery lead, and that the ends of the battery bracket are pushed tightly against the cell itself to insure good contact. Then tighten the battery bracket screws. Never allow an exhausted cell to remain in the instrument, since chemicals from the cell may damage components.

The cell itself and damage caused to the instrument by leaking cells are expressly exempted from our standard warranty.

Tube Replacement - Whenever a tube is replaced, the new tube should be aged for 48 hours. The tube may be aged by operating the instrument for this period with no input. After tube replacement and ageing the instrument must be recalibrated. (See Calibration section).

It may be necessary to select replacement tubes. If the replacement 12AU7 is not in proper balance the SET ZERO control will not cover its range. This control should vary the meter pointer from 60% of full scale to less than zero on "+" and from 10% of full scale to less than zero on "-".

If this is not the case use another 12AU7. Improper matching of the 6AL5's (V202, V203) will result in a shift in the pointer when switching from high to low ranges in the AC position with no input. If the pointer does not remain at zero for all ranges replace the 6AL5's and recalibrate.

CALIBRATION

The Model 201 has been factory calibrated and inspected before being shipped. The accuracy of the instrument after recalibration can never exceed the accuracy of the voltage standards used.

The instrument should always be calibrated in the following order. If the instrument will not calibrate, follow the procedures outlined in the general maintenance section and the troubleshooting section. Whenever possible the unit should be checked after calibration with voltages of known magnitude.

Meter Zero - The meter pointer is mechanically zeroed with the power off by turning the small plastic screw in the meter face.

DC Calibration -

1. Plug the instrument in, turn the function switch to "+" and allow a 5 minute warm up.
2. Adjust the SET ZERO control for a zero reading on the meter. Turn the function switch to "-" and make sure that the meter pointer does not move. If it does, adjust the mechanical zero and repeat this procedure.
3. Plug the Model 953 probe, with its switch in the DC position, and the common (black) test lead into their appropriate sockets. Return the function switch to "+".
4. Turn the range switch to a range appropriate to the available standard voltage. The calibrating voltage should always be a full scale reading on the meter. 50 volts is recommended.
5. Connect the a-c/d-c probe to the positive side of the known voltage and the common lead to the negative side. Adjust the DC + ADJ control (R227) so that the meter pointer indicates the correct voltage.

6. Turn the function switch to "-", reverse the test leads and repeat steps 3 to 5 adjusting the DC - ADJ control (R226). This completes the d-c calibration.

AC Diode Compensation - To compensate for diode characteristics an a-c adjustment has been included in this instrument. To adjust, turn the function switch and the probe switch to AC and short the probe to the common lead. Set the range switch to 1.5 volts and adjust the AC ADJ control (R208) to make the pointer read zero. If the meter pointer will not zero with this adjustment remove the two 6AL5's (V202, V203) and interchange them. If this does not help replace both tubes.

AC Frequency Response Adjustment - Set the instrument up as described under AC Diode Compensation but with the range switch at 150V. Apply a 150 volt, 100 kcs test signal to the probe. If the diode compensation is correctly set the meter will read full scale. Turn the range switch to the 500 volt range and adjust the trimmer capacitor located on the range switch (C206) for a meter deflection of 150 volts.

Resistance - The resistance circuit should require no adjustment. Inaccuracies in resistance measurements indicate a weak battery or faulty circuit components.

TROUBLESHOOTING

The Model 201 is carefully built to give long, troublefree service. However, after prolonged or abusive use tubes or other circuit elements may require replacement. Tubes are the most frequent source of trouble in any electronic instrument, therefore, replace the tubes before seeking other difficulties. Whenever a tube is replaced follow the procedures outlined in the General Maintenance section of this manual.

When other malfunctions arise in the instrument first try to localize the difficulty. If the trouble occurs only on the resistance ranges the battery is probably at fault. Inaccuracies in the a-c ranges indicate faulty tubes, (V202, V203) or capacitors (C205, C207). If a difficulty arises on one or two

ranges, or on all the ranges higher than one particular range, examine the scale resistors on the range switch for shorting or breakage. Malfunctions involving all ranges and functions are generally due to power supply (V203A, C201) or voltmeter tube (V201) failures.

Figure 3, a schematic diagram of the circuit, includes notations of typical voltages at various points in the circuit. Measurement of corresponding voltages in an inoperative instrument may help isolate difficulties.

PARTS LIST

PRINCIPAL COMPONENTS

Should replacement be necessary, the components listed should be duplicated exactly. These may be obtained from the factory if not locally available. Parts not listed but shown on the schematic are standard and may be replaced by similar components of the same value.

Detail No.	Stock No.	Description
RESISTORS		
R208	S1-3932	Potentiometer, 2.5M 1/2W, 20%, linear
R209	1-2864	10K, 1%, 1/2W, carbon film
R210	1-2313	20K, 1%, 1/2W, carbon film
R211	S1-3378	70K, 1%, 1/2W, carbon film
R212	1-2867	200K, 1%, 1/2W, carbon film
R213	S1-3376	700K, 1%, 1/2W, carbon film
R214	S1-3375	2M, 1%, 1/2W, carbon film
R215	S1-3374	7M, 1%, 1W, carbon film
R223	S1-3373	Potentiometer, 20K, 20% 1/2W, linear
R226, R227	S1-3371	Potentiometer, 10K, 20% 1/2W, linear
R228		Same as R223

Detail No.	Stock No.	Description
RESISTORS (cont'd)		
R229	S1-3369	90Ω, 1%, 1/2W, carbon film
R230	S1-3368	900Ω, 1%, 1/2W, carbon film
R231	S1-3367	9K, 1%, 1/2W, carbon film
R232	S1-3366	90K, 1%, 1/2W, carbon film
R233	S1-3365	900K, 1%, 1/2W, carbon film
R234	1-1375A	9M, 1%, 1W, carbon film
R235	S1-3363	9.75Ω, 1%, 1/2W, wire-wound
R236	S1-5689	18 Meg, 1%, 2W, carbon film
R237	S1-3361	150K, 1%, 1/2W, carbon film
R238	S1-5683	320K, 1%, 1/2W, carbon film
R239	S1-3359	900K, 1%, 1W, carbon film
CAPACITORS		
C201	S2-3358	12 μf, -10 +100%, 250V, electrolytic
C202	S2-3357	3300 μμf, ±20%, 600V mica
C203		Same as C202

Detail No.	Stock No.	Description
CAPACITORS (cont'd)		
C204	2-0763	.1 μf, 400V, paper
C205	2-2150	.05 μf, 400V, paper
C206	S2-5346	3-12 μμf, ceramic trimmer
C207	2-1080	.1 μf, 600V, paper
MISCELLANEOUS		
T201	S6-3382	Transformer, power Primary: 117V, 50-60 cycle. Secondaries: 117V, 5ma., d-c; 6.3V 1.2 amp
S201	S12-3384	Switch, 5-position 3-section, 7 circuit
S202	S12-5682	Switch, 7-position, 5-section 5 circuit
M201	S15-3878	Meter, D.C., 0-200 μ amps
J201	17-3294	Pin jack, red, nylon
J202	S17-5655	Jack, miniature socket
J203	11-3295	Pin jack, black, nylon
	S24-5667	Knob, 1/2", vinylgrip
	S24-5659	Knob, bar, 1-1/4"buff polished
PROBES		
Model 954	S20-3728	Test leads -red & black 1 set
Model 953	S22-5011	AC/DC switch probe with detachable cable

Detail No.	Stock No.	Description
PROBES (cont'd)		
* Model 952		AC/DC illuminating probe
* Model 951		High voltage probe
* Model 950		Crystal probe

* Accessories available on special order

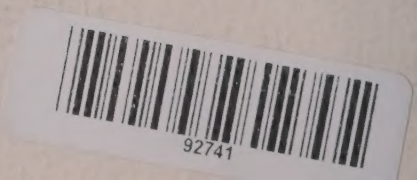
WARRANTY

Every instrument manufactured by the Shasta division of Beckman Instruments, Inc. is warranted to be free from defects in material and workmanship. Our obligation under this warranty is limited to repairing or replacing any instrument or part thereof, except tubes, which shall within one year from date of shipment to the original purchaser prove to be defective after our examination.

Instruments to be repaired must be returned to the factory with transportation charges prepaid. Repair work will be performed only upon receipt of a written purchase order or authorization.

Claims for damage in shipment should be filed promptly with the transportation company. All correspondence concerning the instrument should specify the model and serial number. This information appears on the instrument.

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing.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